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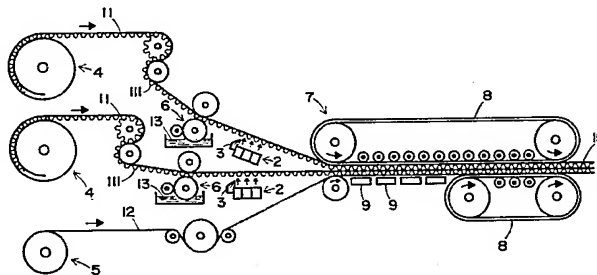
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⑤④ **Apparatus for producing corrugated cardboard.**

⑤⑦ An apparatus for producing corrugated cardboard has means (6) for applying a suspension of raw starch in water to the crests (111) of a corrugated core of at least one half-lined corrugated paper (11); means (2) for directing reheated dry steam onto the suspension to cause gelation of the starch; and means (7), including heater plates (9), for pressing and bonding the paper (11) to a liner (12).



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APPARATUS FOR PRODUCING CORRUGATED CARDBOARD

5 As is well known, corrugated cardboard i.e.
cardboard with a corrugated core, is produced by
forming a half-lined corrugated paper by bonding a
corrugated paper and a liner to one another, and then
bonding another liner to the half-lined corrugated
10 paper. In some cases, two or more sheets of
half-lined corrugated papers are laminated to
constitute a "double-backer" or thicker cardboards.

 A synthetic resin adhesive such as an emulsion
of polyvinyl acetate can be used most suitably as the
15 adhesive for the bonding. However, to cope with the
demand for lower production cost, efforts have been
made to use less-expensive adhesives. As an example
of such efforts, it has been attempted to use raw
starch dispersion, i.e. starch particles dispersed
20 and suspended in water. This dispersion is applied
to the corrugated paper and, after laying the liner
on the corrugated paper, heat and pressure are
applied to cause gelation of the starch dispersion
into a starch paste adhesive.

25 The heating under pressure is usually conducted
by moving the liner in sliding contact with an array
of heat plates, i.e. metallic plates which serve as a
heating medium. The heat plates, however, require a
considerably large installation area and consume an
30 impractically large amount of energy. In addition,
the heat plates often cause undesirable scratches and
warp in the corrugated cardboard product.

 To obviate this problem, it has been proposed to
heat and gelate the raw starch dispersion applied to
35 the half-lined corrugated paper, in advance to the
superposition of the paper and the liner (see
Japanese Patent Publication No. 24658/1972).

 This method is superior in that it dispenses

with the use of the heat plates but has caused a new problem that the yield, i.e. production rate, is low. Usually, the gelation by heat of the raw starch dispersion if effected by blowing steam from nozzles
5 against the applied raw starch dispersion. The production rate of the corrugated cardboard will be increased by increasing the gelation speed by supplying sufficiently large amount of heat to the raw starch dispersion. However, the normally used
10 steam of low pressure, e.g., 0.2 Kg/cm²G, has a temperature of 80 to 85° at the highest as measured at the nozzle outlet. With such steam, it is not possible to provide sufficient heat.

In order to develop a higher temperature, steam
15 of a higher pressure was used experimentally. This, however, proved unsatisfactory, owing to the high energy of the jetted steam undesirably blowing of the raw starch dispersion applied to the half-lined corrugated paper.

Also, blowing of a large amount of steam caused
20 an excessive moistening of the half-lined corrugated paper as a result of condensation of the steam. The moistening of the corrugated paper serves to obviate the warp of the corrugated cardboard product caused
25 by the use of the heat plates, but this merit is cancelled by lower production efficiency attributable to an excessively long time required for the drying of the product. If the moistened corrugated cardboard is sent to the box-making process without
30 drying, various problems are caused, such as dimensional change and insufficient strength of the box.

According to the experience of the present
inventor, a higher bonding strength is obtained by
35 half-gelation of the raw starch dispersion into the state of semi-paste and effecting supplementary heating during and after the pressing to turn the

semi-paste into perfect paste, rather than perfectly
gelating the raw starch dispersion at once prior to
the pressing. This can be attributed to the fact
that the adhesive in the state of semi-paste exhibits
greater penetration into the tissue of the liner
paper. From this point of view, the art shown in
Japanese Patent Publication No.24658/1972 preferably
makes use of the conventional heat plates, rather
than relying solely thereon.

Accordingly, it is a primary object of the
present invention to provide a production apparatus
of the type in which the raw starch dispersion is
gelated first imperfectly and then changed into
adhesive by the assistance of the heat plates, thus
overcoming the above-described problems of the prior
art.

According to the present invention, an apparatus
for producing corrugated cardboard comprises means
for continuously supplying at least one half-lined
corrugated paper and a liner, means for applying a
suspension of raw starch in water to the crests of
the corrugations of the half-lined corrugated paper,
means for blowing steam against the applied raw
starch thereby to cause partial gelation of the raw
starch, means for forming the corrugated cardboard by
pressing the at least one half-lined corrugated paper
and the liner to bond them together, and means for
continuously taking up the thus formed corrugated
cardboard; wherein the means for blowing steam
includes a plurality of tubular bodies extending
across the moving direction of the half-lined
corrugated paper, in use, adjacent to the half-lined
corrugated paper, each tubular body having multiple
nozzles in its surface, which faces, in use, the
applied raw starch, the interior of each tubular body
being divided by ducting for high pressure steam,
into a first manifold and a second manifold which

communicate with one another through steam passages,
the second manifold accomodating a pipe supplying low
pressure steam into the second manifold, the means
for blowing steam further including an air blowing
5 means disposed at the upstream end thereof as viewed
in the moving direction of the half-lined corrugated
paper and having a slit which blows air, in use,
towards the applied raw starch in a direction
inclined towards the moving direction; and wherein
10 the means for forming the corrugated cardboard
includes a heat plate arrranged, in use, to contact
and heat the liner during pressing the at least one
half-lined corrugated paper and the liner.

The new apparatus offers an increase in the
15 production efficiency by realizing a higher speed of
production without any degradation of the corrugated
cardboard product. If the increase in the production
speed is not a matter of concern, the apparatus can
effect the production with reduced energy consumption.

20 The apparatus makes use of steam of low pressure
as the heat source. An important feature, however,
is that this low pressure steam is reheated to become
dry steam which is blown through the nozzles against
the raw starch dispersion. The steam pressure
25 preferably ranges between 0.1 and 0.3 Kg/cm²G,
usually around 0.2 Kg/cm²G. Because of the
reheating, it is possible to obtain easily a high
steam temperature of 125 to 130°C at the nozzle
outlets. By the use of dry steam of this high
30 temperature, it is possible to avoid too strong an
impingement of the steam and also excessive
moistening of the corrugated cardboard.

The means for reheating the steam is the steam
of a high pressure, preferably at 10 to 12 Kg/cm²G,
35 in the ducting.

The heat possessed by this steam is utilized

through heat exchange, namely, the low pressure steam is heated indirectly by the high pressure steam. The high pressure steam may then have its pressure reduced and be used at the low pressure steam.

5 An example of an apparatus constructed in accordance with the invention is illustrated in the accompanying drawings, in which:-

Figure 1 is a diagrammatic side elevation;

10 Figure 2A is a vertical cross-sectional view of the steam blowing means;

Figure 2B is a partly cut-away plan of the steam blowing means as shown in Figure 2A;

Figure 2C is a partly cut-away side elevation of the steam blowing means;

15 Figure 3 is a sectional diagram illustrating the concept of the steam reheating and blowing means;

Figure 4A is a diagrammatic vertical section showing a hood covering the area where the steam is blown;

20 Figure 4B is a vertical cross section corresponding to Figure 4A;

Figure 5A is a side elevation of an optional modification of part of the apparatus; and,

25 Figure 5B is an enlarged sectional view of the part shown in Figure 5A.

As illustrated, an apparatus 1 for producing a corrugated cardboard essentially comprises, as shown in Figure 1, means 4 for continuously supplying at least one half-lined corrugated paper 11 (two sheets of the paper in the illustrated embodiment), means 5 for continuously supplying a liner 12, means 6 for applying an aqueous dispersion of raw starch 13 to crests 111 of the corrugations of the corrugated core of the half-lined corrugated paper, means 2 for
30 blowing steam against the applied raw starch
35 dispersion thereby to cause partial gelation of the raw starch dispersion into paste, means 7 for forming the corrugated cardboard by pressing the at least one

half-lined corrugated paper 11 and the liner 12 to
bond and unite them together, and means 8 for
continuously taking up the thus formed corrugated
cardboard. As shown in Figure 2, the means 2 for
5 blowing steam is housed by a plurality of cases 21A,
21B, 21C in the form of tubular bodies disposed near
and below the half-lined corrugated paper and
extending across the moving direction of the
half-lined corrugated paper. Each tubular body has
10 multiple nozzles 24, 24 ... in its upper surface.
The space in each in each tubular body is divided by
integral central pipes 23, 23 constituting ducts for
high pressure steam into a first upper manifold 28
and a second lower manifold 26 which communicate with
15 one another through steam passages 27 formed between
the adjacent pipes 23, 23.

The lower manifold 26 accomodates a pipes 22 for
supplying low presure steam. An air blowing means 3
is disposed on the upstream side of the upstream
20 tubular body as viewed in the moving direction of the
half-lined corrugated paper and has slit 31 which
blows air in a direction inclined towards the moving
direction of the half-lined corrugated paper 11. The
means 7 for forming the corrugated cardboard includes
25 means for contacting and heating the liner 12, e.g.,
heat plates 9, 9, 9 ... in the illustrated
construction, during pressing of the at least one
half-lined corrugated paper 11 and the liner 12.

The low pressure steam, supplied through the
30 pipe 22 at a rate regulated by a regulating valve,
flows into the lower manifold 26 through nozzles 221
and then flows through the passgaes 27 while being
heated by the high pressure steam flowing through the
pipes 23, 23 at both sides of each passage 27 up to
35 the desired temperature. The heated low pressure
steam is then blown through the nozzles 24 into the
upper manifold 28.

An arrangement as shown in Figure 3 is preferably used when it is desired to utilize the heat possessed by the high pressure steam in advance of the reduction of the pressure of this steam to low pressure. Thus, the high pressure steam from a high pressure steam source STM is introduced into the pipes 23 through a valve Vs_1 and, after the heat exchange, delivered to a pressure reducing valve R in which the pressure is reduced to a low level. The low pressure steam is then introduced through a valve Vs_2 and jetted from the nozzles in the pipe 22. A symbol T represents a steam trap.

The air blowing means disposed at the upstream side of the steam blowing means receives air which is supplied from a compressed air source AIR after a pressure regulation by a valve V_A , and blows air through the slit 31 to form a stream of air which is inclined in the direction of flow of the half-lined corrugated paper 11. This air plays two roles, one of which is to dilute the steam blown through the nozzles 24 significantly to lower the temperature thereof so as to create such a condition that the steam impinges gently near the slit and then, at further points, progressively strongly. If the steam at a high temperature impinges strongly and at a large rate on the raw starch dispersion applied to the crests of the corrugations of the half-lined corrugated paper, the gelation takes place rapidly only in the surface region of the starch dispersion to produce a surface solidification of the same, and failing to accomplish the desired uniform half-gelation of the whole of the starch dispersion. Clearly, such surface solidification of the starch dispersion is not desirable for the adhesion of the corrugated paper and the liner to one and other.

Another role of the air blown through the slit

31 is to prevent undesirable half-gelation of the raw starch dispersion in the applying means which may otherwise occur due to heating of the dispersion and the applying means by a flow component of the steam directed towards the upstream side along the half-lined corrugated paper.

The width of the slit 31 and angle of inclination of the air stream, as well as the flow rate and velocity of the air, will be suitably and experimentally determined in accordance with conditions peculiar to each case.

Two or, preferably, three or more steam blowing means are arranged in a side-by-side fashion, and a part or whole of the same is used selectively. A demand for a high rate of production requires correspondingly large heat input to the raw starch dispersion and, hence, a greater number of the steam blowing means to be put into operation. Usually, the operation is started up with only one steam blowing means, i.e., the steam blowing means disposed at the upstream end, and the number of steam blowing means taking part in the operation is gradually increased.

The steam STM of high pressure is supplied to the heat plate 9 after a pressure adjustment by means of a valve Vs_3 .

In the conventional corrugated cardboard production apparatus in which the gelation of the raw starch dispersion is effected solely by the heat plates, the heat plates are supplied with steam of a considerably high pressure, e.g., 10 to 14 $\text{Kg/cm}^2\text{G}$, i.e., steam at a considerably high temperature. In the new apparatus, the heat required for the gelation is shared by both of the blowing steam and the heat plates at the optimum ratio so that a steam of a somewhat lower pressure, e.g., 3 to 6 $\text{Kg/cm}^2\text{G}$, is used suitably.

In order to make sure of the supply of

sufficient heat for the gelation of the raw starch dispersion, it is advisable to use a heat preserving hood 100 as shown in Figure 4. The heat preserving hood is disposed to cover the region opposite to,
5 i.e. facing the nozzles of, the steam blowing means across the half-lined corrugated paper 11 and has such a length that both ends of the hood extend beyond both edges of the half-lined corrugated paper as illustrated. The hood 100 is provided at its
10 upper portion with an exhaust duct 101 to provide a draught out the hood.

By the use of this hood, the steam is distributed as indicated by arrows so that any temperature difference, which may develop between the
15 central portion and both edge portions of the half-lined corrugated paper is obviated to ensure a uniform heating and, hence, a uniform gelation of the raw starch dispersion.

On the other hand, in the production of the corrugated cardboard employing, for example, reinforced core treated with resin, the corrugated sheet is less liable to absorb the moisture. Therefore, if the heating steam is applied immediately after the application of the raw starch
25 dispersion, the bonding strength is lowered owing to insufficient impregnation of the starch occurred in the course of the half-gelation. In such a case, it is preferred to use a humidifying means as shown in Figure 5. This humidifying means is disposed at the
30 upstream side of the means 6 for applying the raw starch dispersion, and is composed of a hood 200 covering the core, i.e., the corrugated core, of the half-lined corrugated paper 11 and one or, preferably, a plurality of nozzles 201 opening within
35 the hood 200 and adapted to blow the steam against the core. The hood 200 preferably covers the region where a roll 203 is disposed, in order to preheat the

half-lined corrugated paper.

In operation, the crests of the corrugated paper are suitably humidified and heated beforehand by the humidifying means, so that the applied raw starch dispersion impregnates promptly and the undersirable low bonding strength is avoided even if the steam is blown immediately after the application of the raw starch dispersion. The humidification can be made by a steam of a comparatively low pressure, e.g., 0.2 to 0.3 Kg/cm²G. Thus, the high pressure steam after the heating of the low pressure steam, as well as the steam after the heating of the heat plates, can suitably be used as the humidifying steam after a pressure reduction as required.

The apparatus can have various forms. For instance, the illustrated steam blowing means 5 can be substituted by various other structures which can perform the same function as the illustrated means 2. It is also advisable to provide a driving means incorporating a rack driven by an electric motor and a pinion so as to drive the steam blowing means 2 up and down as required. Such an arrangement offers an appreciable advantage in the maintenance through, for example, facilitating the cleaning of the pan for receiving the raw starch dispersion and the dispersion applying roller.

The addition or modification as explained above will be readily practiced by those skilled in the art.

The new apparatus brings about various advantages. First of all, it is to be noted that the apparatus provides a remarkable increase in the yield or production rate of the corrugated cardboard. As explained before, this is achieved by such an arrangement that the heat required for the gelation of the raw starch dispersion is shared by the low pressure steam blown to the raw starch dispersion and the heat plates at the optimum balance of heat input

ratio therebetween. If the increase of the yield or production rate is not a matter of concern, the apparatus permits the production of corrugated cardboard with reduced energy consumption.

5 Another advantage brought about by the new apparatus resides in an improvement in the quality of the corrugated cardboard product. More specifically, the apparatus eliminates the undesirable warp and line cracking of the corrugated cardboard. In the
10 conventional apparatus in which the heating of the raw starch dispersion is effected by the heat plates solely, a considerably large amount of heat is provided from the heat plates so that a large difference of heat input is developed between the
15 heated side and non-heated side of the half-lined corrugated paper, and this may undersirably warp the product. In addition, since the heat plates have to be heated to a high temperature, e.g. 170°C, the liner is inevitably deteriorated by the heat as a
20 result of contact with the heat plates. Consequently, the strength is lowered and causes line cracking in the product. On the other hand, the gelation of the raw starch dispersion solely by the blowing of the steam tends to cause a warp of the
25 corrugated cardboard product owing to excessive moisture resulting from the use of too large an amount of heating steam. It is quite advantageous that all of these problems can be avoided by the use of the new apparatus.

30 From the foregoing description, it will be understood that the apparatus is useful and effective in the production of corrugated cardboard, particularly of the double-facer type.

CLAIMS

1. An apparatus for producing corrugated cardboard,
the apparatus comprising means (4,5) for continuously
5 supplying at least one half-lined corrugated paper
(11) and a liner (12), means (6) for applying a
suspension of raw starch in water to the crests of
the corrugated paper, means (2) for blowing steam
against the applied raw starch thereby to cause
10 partial gelation of the raw starch, means (7) for
forming the corrugated cardboard by pressing the at
least one half-lined corrugated paper and the liner
to bond them together, and means (8) for continuously
taking up the thus formed corrugated cardboard;
15 wherein the means for blowing steam includes a
plurality of tubular bodies (21A,21B..) extending
across the moving direction of the half-lined
corrugated paper, in use, adjacent to the half-lined
corrugated paper, each tubular body having multiple
20 nozzles (24) in its surface, which faces, in use, the
applied raw starch, the interior of each tubular body
being divided by ducting for high pressure steam,
into a first manifold (28) and a second manifold (29)
which communicate with one another through steam
25 passages (27), the second manifold accomodating a
pipe (22) for supplying low pressure steam into the
second manifold, the means for blowing steam further
including an air blowing means (3) disposed at the
upstream end thereof as viewed in the moving
30 direction of the half-lined corrugated paper and
having a slit (31) which blows air, in use, towards
the applied raw starch in a direction inclined
towards the moving direction; and wherein the means
for forming the corrugated cardboard includes a heat
35 plate (9) arranged, in use, to contact and heat the
liner during pressing the at least one half-lined
corrugated paper (11) and the liner.

2. An apparatus according claim 1, further
comprising a heat-preserving hood (100) facing the
nozzles (24) of the means for blowing steam against
the half-lined corrugated paper and long enough to
5 extend, in use, beyond both edges of the half-lined
corrugated paper (11), the heat-preserving hood being
provided with an exhaust duct (101) to provide a
draught out of the hood.

10 3. An apparatus according to claim 1 or claim 2,
further comprising a humidifying means (200) disposed
upstream, as viewed in the moving direction of the
half-lined corrugated paper, of the means (6) for
applying the suspension of raw starch, the
15 humidifying means including a hood covering the
corrugated core of the half-lined corrugated paper
and one or more nozzles (201) opening in the hood and
arranged, in use, to blow steam against the core.

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FIG. 1.

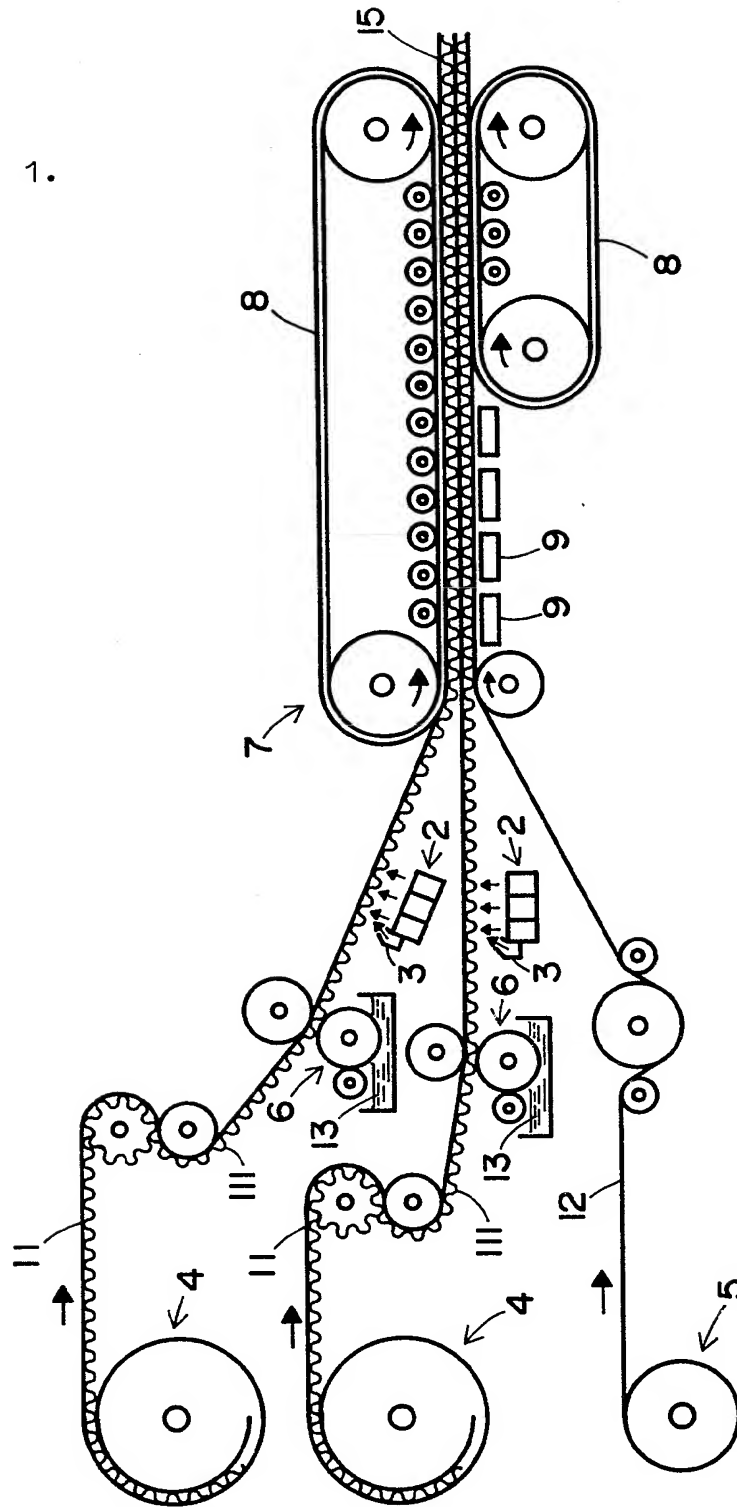


FIG. 2A.

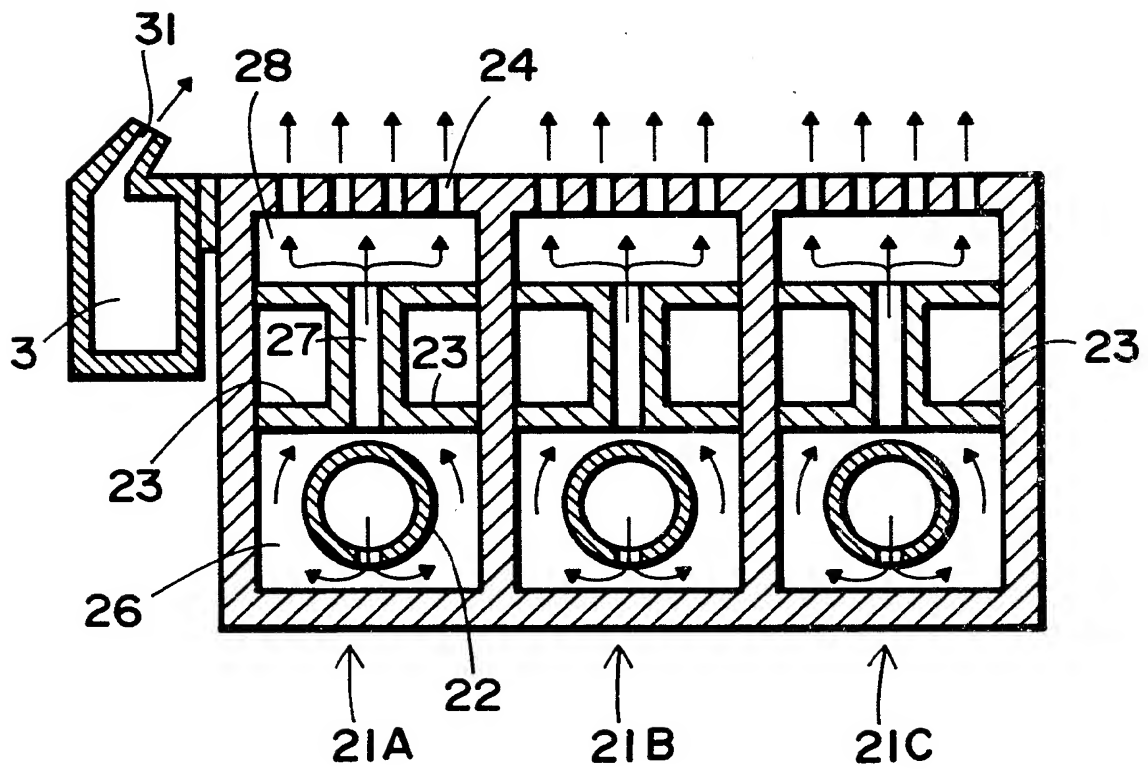


FIG. 2B.

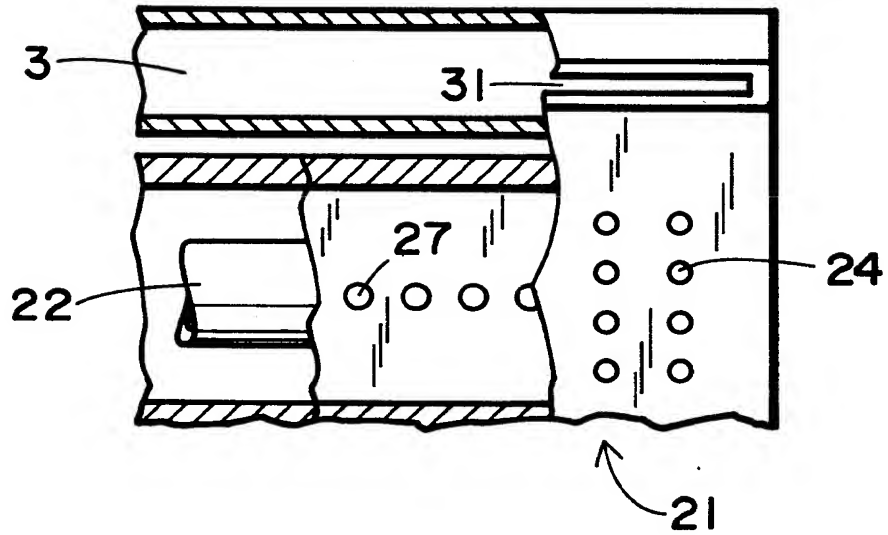


FIG. 2C.

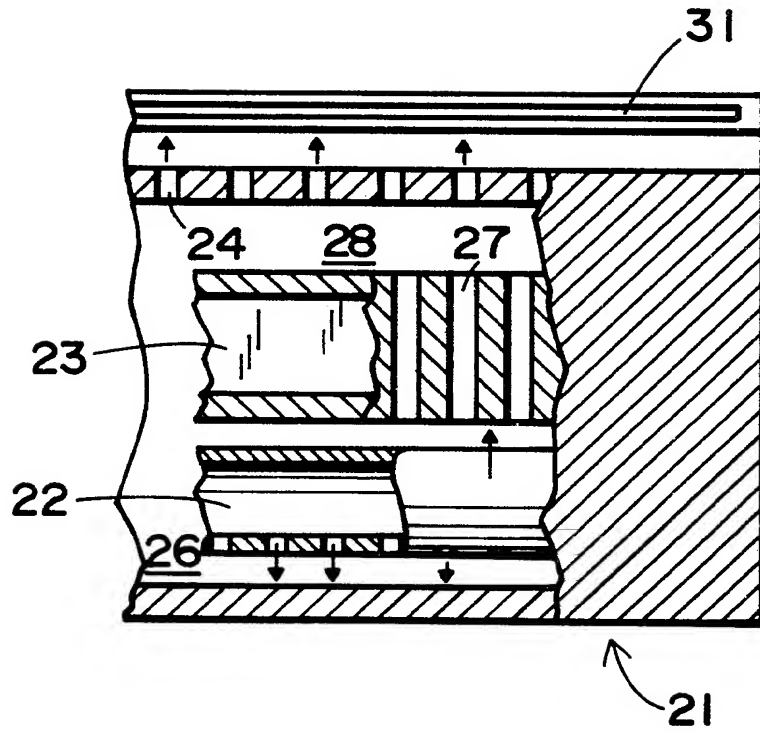


FIG. 3.

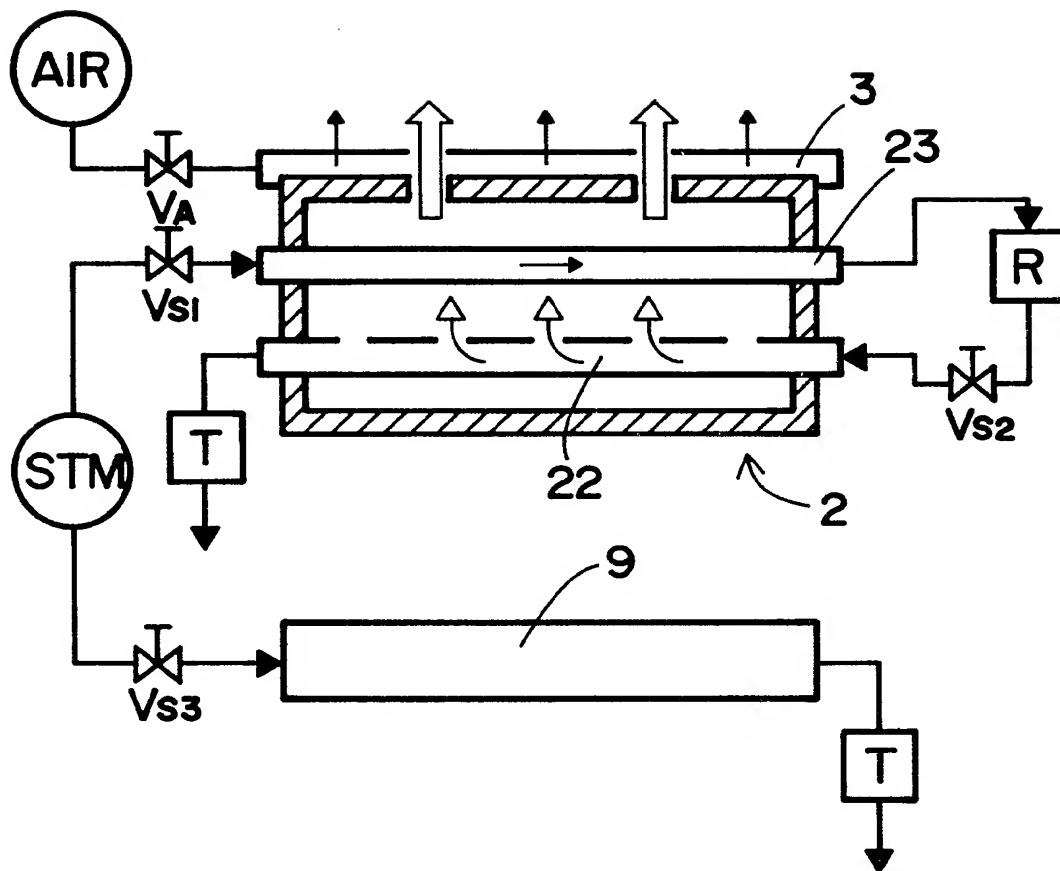


FIG. 4A.

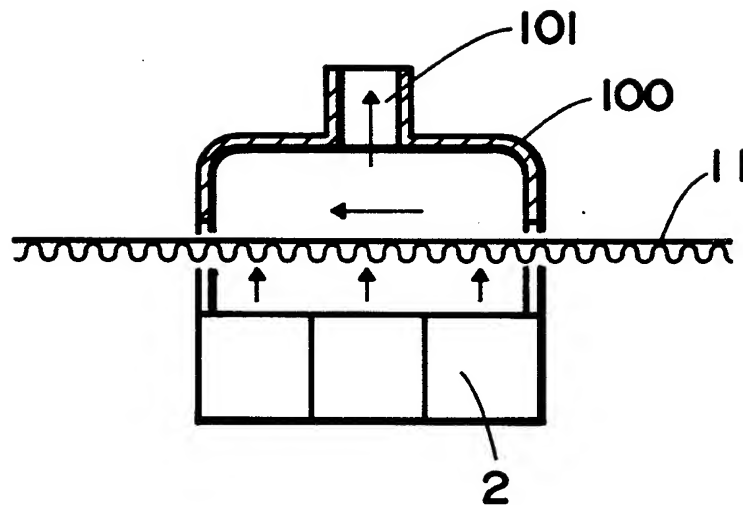
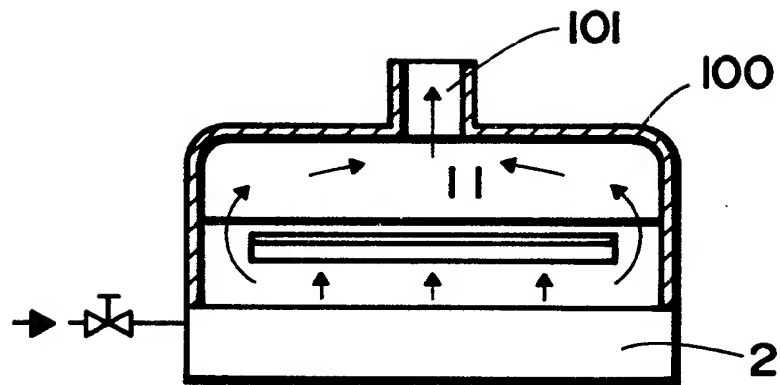


FIG. 4B.



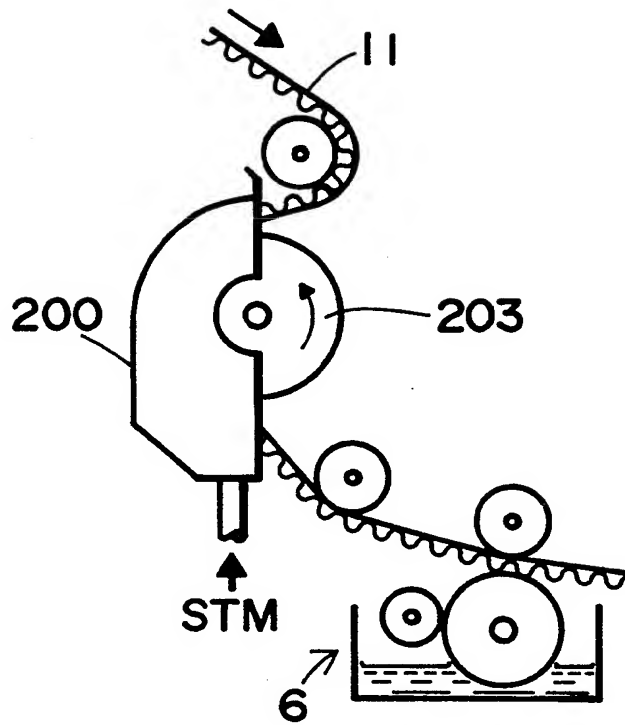


FIG. 5A.

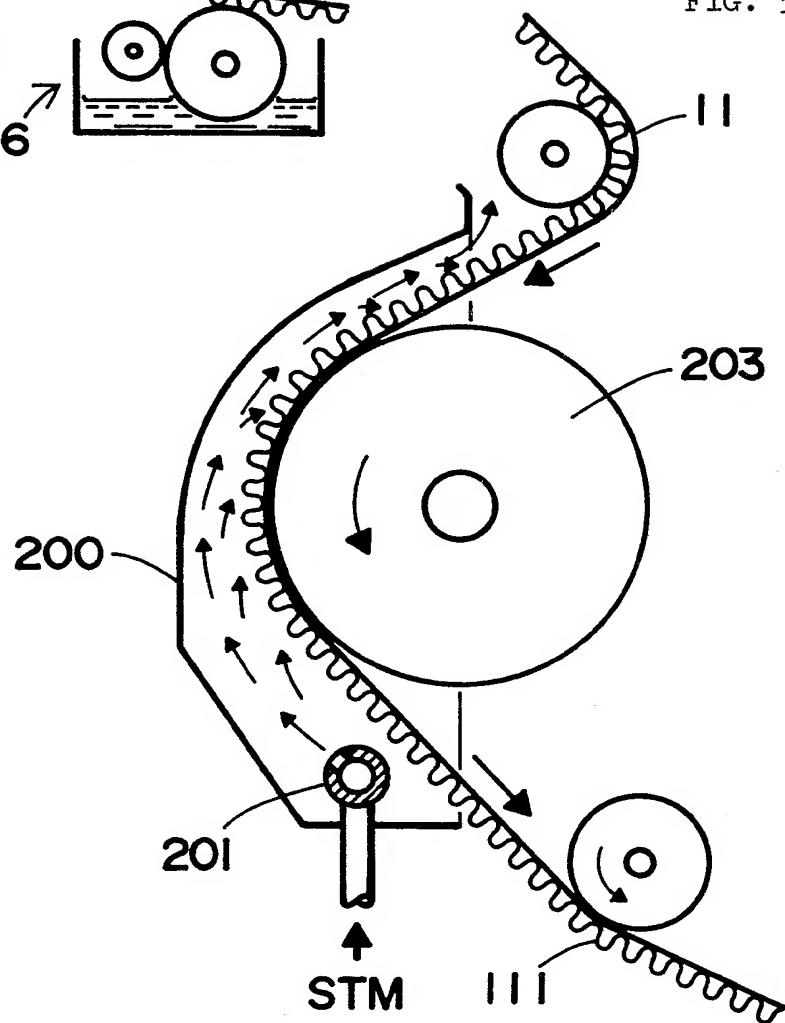


FIG. 5B.